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ABSTRACT

Designed to help the high school industrial arts instructor in teaching power technology, this curriculum guide concentrates on seven subject areas: exploratory power technology, electricity, electronics, small gas engines, automotive repair, transportation, and alternate energy sources. The general course objectives are identified as enabling the student to (1) gain an understanding of how power is produced, controlled, converted, stored, and conserved; (2) place power technology in the broader context of industrial technology; (3) develop an awareness of career opportunities in the power technology industry; (4) select, use, and repair products of the industry as a consumer; (5) develop the ability to work with technically oriented materials and develop logical working procedures; (6) develop responsible and safe working attitudes and practices; and (7) develop a knowledge of shop processes and the care and use of power technology tools and equipment. For each of the seven subjects, an outline of the course content is provided as well as specific behavioral objectives and textbook materials. Various methods of instruction are suggested, including lecture, lecture demonstration, class discussion, lab experiences, and supplementary activities such as field trips, guest speakers, and audiovisual presentations. To insure the effectiveness of the "hands on" laboratory experiences, it is recommended that class size be limited to sixteen to twenty-four students. No specific examinations for student evaluation are provided, although various methods of evaluation of both students and teachers are discussed. A bibliography lists books and microform reproductions on power technology instruction. (ELG)

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A CURRICULUM GUIDE FOR POWER TECHNOLOGY

GRADES 9-12

Graduate Course Paper

Presented to

Industrial Education Department and Graduate School

University of Wisconsin-Platteville

In Partial Fulfillment

of the Requirements for the Master's Degree in

Industrial Arts Education

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by

J. Thomas Callahan

1978

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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A CURRICULUM GUIDE FOR POWER TECHNOLOGY

GRADES 9 - 12

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INTRODUCTION

In today's rapidly changing world, it is not enough that the industrial arts instructor be knowledgeable only in his field. He must become the perennial student of change, and should sense this change through personal contacts with industry, business, and education in his community and the field of education in general.

The purpose of this curriculum guide is to help not only the industrial arts instructor, but also those responsible for planning, developing, and implementing a modern program of industrial arts.

A modern industrial arts curriculum should reflect current trends in technology. Traditional practices such as woodworking, metalworking, and mechanical drawing, should be expanded to include areas that have grown rapidly due to recent technological advances. Such areas would include graphics, plastics, and power technology.

Therefore, the objectives of this curriculum guide are intended to:

1. Aid instructors in the selection and arrangement of teaching material and subject matter.
2. Increase the scope and nature of information and activities offered to students.
3. Develop an interest in the most recent advances in power technology.
4. Aid and enlighten all teachers, counselors and administrators to the potential educational value of power technology,
5. Help keep power technology programs up to date with the most current materials.

6. Help new teachers of power technology develop and design a current and meaningful program.

7. Provide a basis on which advanced technical programs can be built.

INDUSTRIAL ARTS IN GENERAL EDUCATION

Industrial arts is that portion of general education devoted to understanding and solving the technical and human problems brought about by the industrialization and technological advancement of our society. It is especially concerned with technical communication, production, research and development, and consumption.

Industrial arts is a categorical heading for subject matter of its own kind. Just as mathematics includes content such as arithmetic, algebra, geometry, and trigonometry, so industrial arts includes content such as construction technology, drafting, electricity, electronics, graphic arts, wood, metal, and power technology.

Industrial arts may be used to enrich elementary education. Appropriate industrial arts work should be taught to all boys and girls beginning on the middle school level, and continuing through high school. Industrial arts, taught as an exploratory program, gives students an opportunity to identify their interests and aptitudes before they make any decisions which may commit them to a definite occupation or educational goal.

Industrial arts provides a means by which the student can apply in practical and meaningful situations the theoretical principles of science, social studies, mathematics, and other related subjects.

Industrial arts courses in general education must give consideration to the nature and goals of the adolescent youth. Ado-

lescence is a critical time in human development. During this time the student is seeking independence and is sensitive to peer acceptance; he is establishing his value system, expanding his intellectual ability and experiences, and becoming aware of his physical body changes. The first level of industrial arts courses found in the middle school (grades 6-8) should provide orientation to the adult world of work, individual occupations, economics, and ones self. The second level of courses (grades 9-10) should make available broad areas of study, usually categorized as 1) Industrial materials, 2) Power technology, and 3) Visual communications. The third and final level of industrial arts coursework (grades 11-12) should permit continued broad investigations and provide opportunities for individuals to become more selective in content with provision for greater specialization in areas which are most beneficial to the individualized student. Special concerns of the industrial arts courses in these grades are the common learnings needed by all persons to function effectively in our industrial-technical society...attitudes, interests, abilities, skills, problem solving, and an understanding of the world of work.

The levels of competence should not become so specific or involved that one can no longer focus on the whole curriculum. Instead a certain open-mindedness must prevail to permit the program to remain healthy. A favorite quotation taken from an article titled "Industrial Arts," by J. Lloyd Trump, and Delmas F. Miller, clearly explains this concept of the teaching of industrial arts in general education.

> Emphasis in industrial education has never been vocational training. Confusion sometimes arises over this matter. The vocational overtones in industrial arts are secondary. Vocational education demands specialization

> and depth preparation that are not stressed in the industrial arts shop. The primary objective is to give pupils a wide range of preparatory experiences that will lead to later vocational choice or avocational pursuits.... Even if no vocational choice results, avocational skills learned in general shop may result in personal satisfaction, and worthwhile leisure activities.[1]

Objectives of Industrial Arts

The objectives for industrial arts must be carefully selected and developed, so that the goals of teaching industrial arts are fully satisfied. The five objectives listed below are felt to be specific to the industrial arts field, and should be emphasized in the program of instruction.

The students will have an opportunity to:

1. Develop an insight and understanding of industry and its place in our culture.
2. Discover and develop talents, aptitudes, interests of individuals, for the technical fields and applied sciences.
3. Develop an understanding of industrial processes and the practical application of scientific principles.
4. Develop basic skills in the proper use of common industrial tools, machines, and processes.
5. Develop problem solving and creative abilities involving various materials, processes, and products of industry.

In conclusion, the objectives of industrial arts are those of general education, and instruction in industrial arts should be valuable to any person regardless of his vocational choice.

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[1]J. Lloyd Trump and Delmas F. Miller, Secondary School Curriculum Improvement (Boston, Massachusetts: Allyn & Bacon, Inc., 1968), p. 132)

POWER TECHNOLOGY AS A PART OF INDUSTRIAL ARTS EDUCATION

Within that portion of general education called industrial arts, there have been three broad areas of study categorized. These areas have been defined as 1) Industrial materials, 2) Power technology, and 3) Visual communications. This curriculum guide is to study only one of these areas in any depth. This area is power technology.

Since early time, man has always been concerned with efficient means of moving loads, transporting himself from place to place, and accomplishing work more efficiently than could be done by manpower alone. The interests concerned with the development, transmission, and utilization of energy more efficiently are called power technology.

In today's highly technical society, knowledge in these areas is growing in importance as evidenced by the tremendous growth in industrialization and mechanization. By offering a wide range of general power technology courses, the students can become better prepared to understand and cope with this continually growing phenomenon.

Objectives of Power Technology

Every student enrolled in a power technology course shall to the limit of his capabilities have the opportunity:

1. To work with power systems in order to gain an understanding of how power is produced, converted, stored, controlled, and conserved.

2. To place power technology in the broader context of industrial technology.

3. To develop an awareness of the career opportunities exist-in the power technology industry.

4. To provide experience and information which will aid the student as a consumer, in the selection, use, repair, and care of the products of the power industry.

5. To develop the ability to read, interpret, and work from technically oriented materials, and to develop logical procedures in diagnosis, assembly, disassembly, repair, and inspection.

6. To develop responsible and safe working attitudes and practices, when functioning alone or as a member of a team.

7. To develop a knowledge of shop processes and the care and use of tools, machines, and test equipment appropriate to power technology.

COURSE DESCRIPTIONS

The following seven courses are designed to develop the understanding of power technology for high school students.

Exploratory Power Technology - Grades 9, 10, 11 - 1 semester

As a basic overview, this course forms a foundation for all other power tech courses. "Prime movers" and "building block" power sources are discussed and investigated. Suggested for both Industrial Arts majors and non-majors as an initial starting point in the power tech area.

Electricity - Grades 9, 10 - 1 semester

By tracing the history and usage of electricity up to the present day, methods of manufacture, distribution, and service are discussed. Basic theories and principles are investigated with an emphasis on safe handling practices. A unit in basic house wiring is included.

Electronics - Grades 11, 12 - 1 semester

Circuit and transistor theory, exposure to solid state devices, and a look at the current "state of the art" are found in this course. Kit based projects will be completed in class with particular attention paid to assembly and craftsmanship. This is not a TV or radio repair course.

Small Gas Engines - Grades 9, 10 - 1 semester

An introduction to the basic theory of the internal combustion engine is put to work in a student directed, hands-on course. Bench testing, trouble-shooting, overhaul, and assembly techniques are emphasized. Students are encouraged to bring projects from home to be worked on in the school laboratory. Suggested for freshmen and sophomores.

Automotive Repair - Grades 11, 12 - 1 or 2 semesters

As a course aimed at demonstrating preventive and corrective maintenance, it is geared for both males and females. The exploration of various automotive systems provides a

clearer concept of what really ahppens when the ignition key is turned. Work is limited to minor repairs as selected by the instructor.

Transportation - Grades 9, 10 - 1 semester

A course devoted to examining various transportation systems that have been in the past, present, and will be in the future. Primarily an investigative course, much time will be devoted to library research and class discussions.

Alternate Energy Sources - Grades 11, 12 - 1 semester

A hard look at the current use of energy and what possible solutions there are for solving our energy dilemma. Emphasis is placed on the contemporary topics (including solar energy) and their part in the energy shortage solution.

COURSE OUTLINES

A detailed outline of the suggested course content for each of these seven courses follows in outline form.

EXPLORATORY POWER TECHNOLOGY

I. Introduction and shop orientation
II. Safety
    A. Shop
    B. Applied to mechanical and electrical devices in general
III. Measurement
    A. Systems
        1. English
        2. Metric
    B. Tools
        1. General
            a. Rulers
            b. Scales
        2. Precision
            a. Micrometer
            b. Vernier caliper
        3. Gauges (pressured)
        4. Dial (clock face)
IV. Sources of energy
    A. Atomic
    B. Chemical
    C. Fossil fuel
    D. Friction
    E. Heat
    F. Light
    G. Magnetism
    H. Muscle
    I. Water
    J. Wind
V. Harnessing energy
    A. Batteries
        1. Construction
        2. Uses
        3. Advantages and disadvantages
    B. Combustion
        1. Internal combustion
            a. 2 stroke cycle
            b. 4 stroke cycle
            c. Diesel
            d. LP gas
            e. Piston
            f. Rotary
                1. Turbine
                2. Wankel

2. External combusion
   a. Steam
      1. Piston
      2. Turbine
3. Reaction engines
   a. Jets
   b. Rockets

C. Electricity
1. Generation
2. Utilization
   a. Alternating current
   b. Direct current

D. Fuel cell
1. Principles
2. Operation

E. Atomic reactors
1. Theory of operation
2. Safety
3. Environmental considerations

F. Solar
1. Produce electrical
   a. Expense
   b. Efficiency
2. Produce heat
   a. Expense
   b. Applications

G. Thermocouples
1. Theory and operation
2. Application

H. Wind
1. Sails
2. Windmill
   a. Electricity
   b. Mechanical

I. Water
1. Direct
   a. Water wheel
   b. Turbine
   c. Tidal
2. Indirect
   a. Electrical generation

VI. Transmission
A. Primemovers
1. Levers
   a. First class
   b. Second class
   c. Third class
2. Wheel and axle
3. Pully

4. Inclined plane
5. Wedge
6. Screw

B. Mechanical controls
1. Linkage
2. Cables
3. Gears
4. Crank shaft
5. Chain
6. Belts

C. Electrical controls
1. Conductors
2. Switches
3. Transformers
4. Circuit breakers

D. Hydraulic - Pneumatic controls
1. Pump - compressors
a. Piston
b. Rotary
c. Gear
2. Working fluids
3. Working components
a. Cylinders
b. Diaphrams
c. Motors
4. Valves and servos
5. Regulators

VIII. Power Applications
A. Transportation
B. Manufacturing
C. Home life

IX. Occupations involved with or related to power technology
A. Chemical engineer
B. Electrician
C. Auto/truck/tractor mechanic
D. Industrial designer
E. Auto/truck/tractor assembly line worker
F. Hydraulics engineer
G. Gear machinist
H. Sail maker
I. Hydro-electric plant operator

BEHAVIORAL OBJECTIVES - EXPLORATORY POWER TECHNOLOGY

A student enrolled in exploratory power technology shall be able to:

1. Learn the definitions and measurement of work, energy, power, and related terms used in power technology.

2. Understand the basic principles found in the manufacture, storage, and transmission of power.

3. Explain the past, present, and future development of power, and its effect on our lives.

4. Demonstrate shop skills through the design and construction of individual and group projects.

5. Develop an appreciation of quality materials and good workmanship involved in the selection of power devices.

6. Become aware of occupational opportunities in power technology, and possibilities for further experience and education.

SELECTED TEXTBOOKS FOR EXPLORATORY POWER TECHNOLOGY

Bohn, Ralph C. and Angus, J. McDonald. Power: Mechanics for Energy Control. Bloomington, Illinois: McKnight Publishing Co., 1970.

Duffy, Joseph W. Power: Prime Mover of Technology. Bloomington, Illinois: McKnight Publishing Co., 1972.

Stephenson, George E. Power Technology. Albany, New York: Delmar Publishers, Inc., 1968.

Worthington, Margules, and Crouse. General Power Mechanics. New York, New York: McGraw-Hill Book Company, 1968.

ELECTRICITY

I. Introduction and shop orientation
II. Safety
    A. Shop
    B. Applied to electricity and electrical devices
III. Measurement
    A. Systems
        1. English
        2. Metric
    B. Tools
        1. General
            a. Rulers
        2. Electrical
            a. Volt ohm meter
            b. Wire gauge
IV. Electron theory
    A. People important in field of electricity and electronics
        1. Coulomb
        2. Ohm
        3. Faraday
        4. Volta
    B. Units of electricity
        1. Voltage
        2. Currents
        3. Resistance
        4. Power
        5. Ohms law
    C. Conductors and insulators
        1. Good conductors (bad insulators)
        2. Bad conductors (good insulators)
V. Electrical circuit configuration
    A. Electrical symbols
        1. Power source
        2. Conductors
        3. Loads
            a. Resistance
            b. Motors
            c. Lights
        4. Controls
            a. Switches
            b. Relays
    B. DC electrical circuits
        1. Series
        2. Parallel
        3. Series-parallel

Electricity

VI. Sources of electricity
  A. Natural
    1. Lightning
    2. Static electricity
  B. Generation
    1. Generators
    2. Alternators
  C. Other sources
    1. Chemical
      a. "Dry" cell batteries
      b. "Wet" cell batteries
    2. Photoelectricity
    3. Thermo electricity
    4. Piezoelectricity
    5. Bio electricity

VII. Magnetism
  A. Magnets
    1. Permanent
    2. Temporary
    3. Electromagnetic
  B. Transformers
  C. Generators
  D. D. C. motors
    1. Permanent
    2. Electro magnetic type

VIII. Testing and measuring electrical energy or voltage
  A. Simple test
    1. Continuity
    2. For electricity
  B. Meters
    1. Voltmeter
    2. Ammeter
    3. Ohm meter
  C. Advanced instruments
    1. VOM
    2. VTVM
    3. Signal generator
    4. Oscilloscope

IX. Electrical energy for consumers
  A. Safety
    1. Indoors
    2. Outdoors
  B. Protective devices
    1. Fuses
    2. Circuit breakers
    3. Ground fault indicators
  C. Electrical codes
    1. Minimum requirements
    2. Wiring color code

Electricity

D. House wiring
    1. Distribution
        a. Electric meter
        b. Wiring
    2. Loads
        a. Outlets
        b. Permanent wiring
    3. Controls
        a. Common switches
        b. 3-way switches
        c. 4-way switches

X. Occupations involved with or related to electricity
    A. Residential electrician
    B. Industrial electrician
    C. Telephone installer
    D. Motor troubleshooter
    E. Small appliance repairman
    F. Electrical inspector
    G. Electrical engineer

BEHAVIORAL OBJECTIVES - ELECTRICITY

A student enrolled in electricity shall be able to:

1. Learn concepts, principles, and laws surrounding the theory of electrical energy.

2. Understand basic applications of the field of electrical energy.

3. Develop safe practices and procedures in working with electrical energy.

4. Demonstrate a general understanding of different types of basic circuits.

5. Develop an appreciation of quality materials and good workmanship involved in the selection of electrical devices.

6. Become aware of occupational opportunities in electricity, and possibilities for further experience and education.

SELECTED TEXTBOOKS FOR ELECTRICITY

Graham. Fundamentals of Electricity. Chicago, Illinois: American Technical Society, 1968.

Lopel and Ahr. Introduction to Electricity and Electronics. Albany, New York: Delmar Publications, 1968.

Lush, C. K. and Engle, G. E. Industrial Arts Electricity. Peoria, Illinois: Charles A. Bennett Company, Inc., 1971.

Robinson, Vester. Basic Principles of Electricity. Reston, Virginia: Reston Publishing Company, 1973.

Steiberg, and Ford. Electricity and Electronics Basic. Chicago, Illinois: American Technical Society, 1972.

ELECTRONICS

I. Introduction and shop orientation
II. Safety
    A. Shop
    B. Applied to electricity and electrical devices
III. Measurement
    A. Systems
        1. English
        2. Metric
    B. Tools
        1. General
            a. Ruler
        2. Precision
            a. Micrometer
    C. Electrical
        1. Volt ohm meter
        2. Vacuum tube voltmeter
        3. Oscilloscope
        4. Other meters: I, V, Power, RPM
IV. Review of electron theory
    A. Units of electricity
        1. Voltage
        2. Current
        3. Resistance
        4. Power
    B. Relationships
        1. Ohms law
        2. Watts law
    C. D. C. Circuits
        1. Series
        2. Parallel
        3. Series - parallel
V. AC and DC circuit characteristics
    A. Resistors
    B. Capacitors
    C. Inductors
    D. Transformers
    E. Semi-conductors
    F. Vacuum tube
    G. Transistors
VI. Electronic circuitry
    A. Handwired
    B. Printed circuits

1. Materials
2. Design
3. Fabrication

C. Integrated circuits
1. Theory
2. Construction
3. Application

D. Modular circuit construction
1. Building blocks
2. Plug-in black boxes

VII. Electronic circuitry

A. Audio amplifiers
1. Theory
2. Design
3. Operation
4. Application

B. Power supplies
1. Theory
2. Design
3. Operation
4. Application

C. Radio
1. Theory
2. Signal processing
3. AM/FM
4. 2-way transmission

D. Television
1. Theory
a. Black and white
2. Signal processing
3. AM/FM
4. Color television

VIII. Troubleshooting simple circuits

A. Review meter characteristics
1. Volt ohm meter
2. Vacuum tube volt meter
3. Oscilloscope

B. Signal generator
1. Audio frequencies
2. Radio frequencies
3. VHF and UHF

C. Signal tracer

D. Tube tester

E. Transistor testing

IX. Consumer knowledge

A. Radio
1. AM
2. FM

3. Citizen's band
4. Ham

B. Television
1. Color
2. Black and white

C. High fidelity equipment
1. Stereo
2. Record changers
3. Tape decks

D. Communications methods
1. Telephone
2. Optical
3. Coded
4. Cable TV
5. Earth satelite

E. Appliances
1. Microwave
2. Solid state controls

F. Electronic equipment
1. Test circuits
2. Light organs
3. Control systems

G. Kits
1. Heath
2. Archer
3. Marcraft

X. Occupations involved with or related to electronics
A. Electronics engineer
B. Electronics technician
C. Communications technician
D. Radio-TV repairman
E. Radio-TV engineer
F. Automotive ignition specialist
G. Cable TV installer

BEHAVIORAL OBJECTIVES - ELECTRONICS

A student enrolled in electronics shall be able to:

1. Develop a fundamental knowledge of the theory of electronics, electronic circuits, and electronic components.

2. Recognize and utilize the various electrical and electronic components that are used in the electronics industry.

3. Exercise proper safety techniques while working in an environment that includes electrical and/or electronic equipment and circuits.

4. Demonstrate basic trouble-shooting techniques on electronic components, circuits, and systems.

5. Develop an appreciation of quality materials and good workmanship involved in the selection of electrical devices.

6. Become aware of occupational opportunities in electricity, and possibilities for further experience and education.

SELECTED TEXTBOOKS FOR ELECTRONICS

Alvarez, and Fleckles. Introduction to Electron Devices. New York, New York: McGraw-Hill Book Company, 1974.

Duggel and Gerrish, H. H. Electricity and Electronics. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1977.

Gerrish, H. H. Exploring Electronics. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1971.

Gerrish, H. H. Transistor Electronics. South Holland, Illinois: Goodheart-Wilcox Company, Inc., 1969.

Grob, B. Basic Electronics. New York, New York: McGraw-Hill Book Company, 1971.

Herrick, C. N. Survey of Electronics. New York, New York: Macmillan Book Company, 1973.

SMALL GAS ENGINES

I. Introduction and shop orientation
II. Safety
    A. Shop
    B. Applied to motors and mechanical devices in general
III. Measurement
    A. Systems
        1. English
        2. Metric
    B. Tools
        1. General
            a. Rulers
            b. Scales
        2. Precision
            a. Micrometers
            b. Feelers gauges
        3. Gauges (Pressure type)
    C. Measurement of power
        1. Dynamometers
        2. Theoretical
IV. Construction and operation of a small engine
    A. Basic parts
    B. Base materials
    C. 4 stroke cycle
    D. 2 stroke cycle
V. Compression system
    A. Valves and valve operation
    B. Pistons and rings
    C. Connecting rod and bearings
    D. Overhaul
VI. Ignition system
    A. Electrical theory
    B. The electrical system
        1. Identification
        2. Jobs
    C. Complete magneto cycle
    D. Engine timing
    E. Spark plug
        1. Job
        2. Specifications
VII. Fuel systems
    A. Fuel system

1. Suction
2. Gravity
3. Pressurized

B. Carburetion
1. Basic job
2. Types
a. Float
b. Diaphram
3. Adjustments
4. Overhaul

C. Governors
1. Job
2. Type
a. Mechanical
b. Pneumatic

VIII. Lubrication
A. Types of systems
1. Splash
2. Pressure
3. Mixing

B. Oil designations
C. Bearings
1. Materials
2. Configurations

IX. Cooling system
A. Air
1. Care
2. Principle

B. Water

X. Routine care and maintenance
A. Routine care
1. Oil
2. Fuel
3. Cooling system
4. Spark plug
5. Air cleaner

B. Off-season storage
1. Preparation to store
2. Preparation to return to service

XI. Occupations involved with or relating to small engines
A. Small engine mechanic
B. Outboard motor mechanic
C. Design engineer
D. Materials tester
E. Electrical engineer
F. Chemist
G. Salesman

BEHAVIORAL OBJECTIVES - SMALL GAS ENGINES

A student enrolled in small gas engines shall be able to:

1. Understand the principles of operation of the internal combustion engine.

2. Demonstrate a basic working knowledge of component operations of two and four cycle engines.

3. Learn the correct selection and safe handling of common hand tools and supplies.

4. Demonstrate their ability to service, including disassembling, and reassembling, small gas engines.

5. Develop an appreciation of quality materials and good workmanship involved in the selection of internal combustion engines.

6. Become aware of occupational opportunities in the small engine industries, and possibilities for further experience and education.

SELECTED TEXTBOOKS FOR SMALL GAS ENGINES

General Theory of Operation. Briggs and Stratton Corp., Milwaukee, Wisconsin, 1977.

Pipe, Ted. Small Gasoline Engines. New York, New York: Howard W. Sams and Co., Inc., 1969.

Purvis, Jud. All About Small Gas Engines. Chicago, Illinois: Goodheart-Wilcox Co., 1975.

Roth, Alford C. Small Gas Engines. Chicago, Illinois: Goodheart-Wilcox Co., 1975.

Small Engines - Vol. 2 - Maintenance and Repair. American Association for Vocational Instructional Materials, 1971.

AUTOMOTIVE REPAIR

I. Introduction and shop orientation
II. Safety
    A. Shop
    B. When working on automobiles
III. Measurement
    A. Systems
        1. English
        2. Metric
    B. Tools
        1. General
            a. Ruler
        2. Precision
            a. Micrometer
            b. Feelers gauges
            c. Vernier caliper
        3. Tools
            a. Torque wrench
            b. Sun machine
                1. Tachometer
                2. Dwell meter
                3. Timing light
                4. Vacuum gauge
                5. Compression gauge
                6. Volt meter
IV. Engine
    A. Purpose
    B. Basic Engine Configuration
        1. In line
        2. "Vee" type
        3. Horizontal
    C. Engine components
        1. Block
            a. Bored in block
            b. Sleeves
        2. Manifolds
            a. Intake
            b. Exhaust
        3. Cylinder head
            a. Flat head
            b. Overhead valve
            c. Overhead cam
        4. Valve train
            a. Valves
            b. Rocker arms

- c. Pushrods
- d. Lifters
- e. Guides
- f. Springs
- g. Camshaft
- h. Valve timing

5. Pistons
   - a. Wrist pins
   - b. Rings
6. Connecting rods
7. Crankshaft
   - a. Bearings
   - b. "Throw"
8. Vibration Dampener
9. Gaskets
   - a. Cork
   - b. Neopreme
10. Engine mounts

D. Fuel systems
1. Purpose
2. Methods
   - a. Gravity
   - b. Vacuum
   - c. Pressure
3. Pump
4. Fuel tank
5. Level indicator
6. Fuel line
7. Carburetor
8. Fuel injection
9. Air cleaner
10. Fuels

E. Cooling system
1. Purpose
2. Types
   - a. Air
   - b. Water
3. Components
   - a. Water pump
   - b. Radiator
   - c. Water jacket
   - d. Fan
   - e. Thermostat
   - f. Pressure cap
   - g. Hoses
4. Antifreeze

F. Lubrication system
1. Purpose
2. Bearings
   - a. Ball
   - b. Roller
   - c. Sleeve

3. Oil
4. Oil pump
5. Oil pan
6. Oil filter
7. Oil pressure indicators
8. Oil level indicators

G. Exhaust system
1. Purpose
2. Dangers of carbon monoxide
3. Manifolds
4. Connecting tubing
5. Mufflers

V. Electrical
A. Basic terms and symbols
1. Volts
2. Amps
3. Ohms
4. Circuit
5. Ground
6. Switch
7. Fuse
8. Relay

B. Ignition
1. Purpose
2. Components
a. Battery
b. Distributor
c. Coil
d. Spark plugs
e. Ignition switch
f. Points
g. Condenser
h. Wiring
3. Breakerless ignitions
a. Magnetic
b. Light emitting diode
c. Capacitor - discharge

C. Battery
1. Purpose
2. Construction
a. Conventional
b. "No" maintenance
3. Ratings
4. Using jumper cables

D. Charging system
1. Purpose
2. Methods
a. Alternators (AC)
b. Generators (DC)

3. Voltage regulators
4. Ammeter or indicator lights
5. Drive belt tension
6. Charging battery out of the car

E. Starting system
1. Purpose
2. Starter
3. Solenoid
a. Remote
b. Lever action
4. Bendix drive

F. Electrical circuits
1. Horn
2. Lights
3. Signals
4. Accessories
5. Fuses

VI. Power Train
A. Purpose
B. Clutch
1. Function
2. System
a. Hydraulic
b. Mechanical
3. Parts
a. Flywheel
b. Pressure plate
c. Friction disc
d. Throw-out bearing
4. Adjustment

C. Transmission
1. Purpose
2. Standard
3. Automatic
4. Overdrive
5. Care and maintenance

D. Driveshaft and universal joints
1. Purpose
2. Location
3. Repair
4. Care and maintenance

E. Differential
1. Purpose
2. Gear ratio
3. Types
a. Solid
b. Independent
4. Care and maintenance

VII. Brake system
- A. Purpose of brakes
  - 1. Stopping
  - 2. Parking
- B. Types of systems
  - 1. Mechanical
  - 2. Hydraulic
  - 3. Electric
- C. Components
  - 1. Pedal assembly
  - 2. Master cylinder
  - 3. Brake lines
  - 4. Wheel cylinder
  - 5. Drum
  - 6. Caliper
  - 7. Disc
  - 8. Hand brake
- D. Care and maintenance
  - 1. Bleeding
  - 2. Adjustments
    - a. Manual
    - b. Self

VIII. Frame and suspension
- A. Purpose
- B. Types of construction
  - 1. Frames
  - 2. Unitized
- C. Types of suspension
  - 1. Springs
    - a. Coil
    - b. Leaf
    - c. Torsion bar
  - 2. Shock absorbers
    - a. Regular
    - b. Air
- D. Front end assembly
  - 1. Steering
    - a. Regular
    - b. Power
  - 2. Alignment
    - a. Caster
    - b. Camber
    - c. Toe in
    - d. Toe out
- E. Tires and wheels
  - 1. Selection
  - 2. Side wall designation
  - 3. Mounting
  - 4. Care and maintenance

a. Inflation
b. Balance
c. Flat repair

IX. Base tune up
- A. Maintenance
  - 1. Preventive
  - 2. Corrective
- B. Purpose
- C. Factors
  - 1. Fuel supply
  - 2. Ignition system
  - 3. Compression
- D. Items to be checked
  - 1. Compression
  - 2. Vacuum reading
  - 3. Ignition
  - 4. Analysis of exhaust gases
- E. Service
  - 1. Replace spark plugs
  - 2. Replace and set points and condenser
  - 3. Time engine
  - 4. Adjust carburetors
- F. Parts procurement
- G. Reading specifications

X. Occupations involved with or related to automobiles
- A. Automobile mechanic
- B. Automobile salesman
- C. Race car driver
- D. Tire repairman
- E. Engine rebuilder
- F. Parts store counterman
- G. Body shop/Auto painter

BEHAVIORAL OBJECTIVES - AUTOMOTIVE REPAIR

A student enrolled in automotive repairs shall be able to:

1. Learn basic internal combustion theory, its function and design as related to internal combustion engines.

2. Define and perform basic essential services as classified in corrective and preventive maintenance.

3. Understand the importance of safety and safe practices in operating various power units.

4. Establish the functions of the various systems and their component parts, and their relationship to the combustion principle.

5. Develop an appreciation of quality materials and good workmanship in the selection of automobiles, automotive service, and parts.

6. Become aware of occupational opportunities in the automobile industry, and possibilities for further experience and education.

SELECTED TEXTBOOKS FOR AUTOMOTIVE REPAIRS

Crouse, William H. Automotive Engine Design. New York, New York: McGraw-Hill Book Co., 1971.

Crouse, William H. Automotive Mechanics. New York, New York: McGraw-Hill Book Co., 1975.

Stockel, Martin W. Automechanics Fundamentals. South Holland, Illinois: Goodheart-Wilcox Co., Inc., 1974.

Toboldt, W. and Johnson, L. Automotive Encyclopedia. Homewood, Illinois: Goodheart-Wilcox Co., Inc., 1973.

Webster, J. Automotive Fundamentals for Consumers. Beverly Hills, Calif.: A division of Benziger, Bruce, and Glencoe, Inc., 1976.

Wetzel, G. Automotive Diagnosis and Tune-up. Bloomington, Illinois: McKnight and McKnight, 1974.

TRANSPORTATION

I. Introduction and shop orientation
II. Safety
    A. Shop
    B. Working on transportation devices
III. Measurement
    A. Systems
        1. English
        2. Metric
    B. Distances
    C. General
        1. Ruler
        2. Vernier caliper
IV. History of transportation
    A. Human power
        1. Past
        2. Current
    B. Beasts of burden
    C. Harnessing nature
    D. Mechanical era
V. Why man transports
    A. To relocate food
    B. To seek shelter
    C. For more comfort
    D. To satisfy emotions
    E. To change environments
    F. For recreation
    G. To distribute goods
    H. Other
VI. Where man transports
    A. Overland
    B. Underground
    C. On water
    D. Underwater
    E. In air
    F. In space
VII. How man transports
    A. Overland
        1. Cars
        2. Trucks
        3. Buses
        4. Trains
        5. Trolley
        6. Horse-cart

7. Tractor
8. Skis
9. Bicycle
10. Motor cycle
11. Skateboard
12. Roller skates
13. Electric car
14. Wheel chair
15. Tracked vehicles
16. Snowmobiles

B. Underground
1. Subways
2. Tunnels

C. On water
1. Boats
2. Air foils
3. Hydro-planes
4. Skis
5. Rafts

D. Underwater
1. Submarines

E. In air
1. Airplanes
2. Airships
3. Kites
4. Parachutes
5. Jets
6. Helicopters
7. Escalator
8. Elevator

F. Space
1. Rockets
2. Space stations

VIII. Special transportation problems
A. Mass transit
B. Handling methods
C. Packaging methods
D. Safety
E. Times of transportation
F. Conditions of transportation

IX. Careers and occupations related to transportation
A. Airplane pilot
B. Taxi driver
C. Truck driver
D. Boat builder
E. Automobile mechanic
F. Astronaut
G. Boat captain

BEHAVIORAL OBJECTIVES - TRANSPORTATION

A student enrolled in transportation shall be able to:

1. Understand the basic principles of transportation as related to why, where, and how man transports.

2. Explain the history of transportation and project possible future trends.

3. Discuss specialized problems such as safety, materials handling, etc., as related to transportation.

4. Learn research and communication skills through the use of in-class and extra-class activities.

5. Develop an appreciation of quality materials and good workmanship involved in the selection of transportation devices.

6. Become aware of occupational opportunities in transportation, and possibilities for further experience and education.

SELECTED TEXTBOOKS FOR TRANSPORTATION

Bendixson, Terence. Without Wheels. Bloomington, Indiana: Indiana University Press, 1976.

Gunston, Bill. Transportation: Problems and Prospects. New York: New York: E. P. Dutton and Company, 1972.

Stone, Tabor. Beyond the Automobile. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

* Also consult recent issues of Popular Science and Popular Mechanics for current developments in transportation.

ALTERNATE ENERGY SOURCES

I. Introduction and shop orientation
II. Safety
  A. Shop
  B. Around mechanical devices
III. Measurement
  A. Systems
    1. English
    2. Metric
  B. Heat measurement
    1. BTU
    2. Temperature
  C. General
    1. Ruler
IV. Review of current fuels
  A. Animal waste
  B. Fossil fuels
    1. Coal
    2. Petroleum
    3. Natural gas
  C. Nuclear
  D. Water power
  E. Wood
V. Alternate energies
  A. Development from fuel shortage
  B. Current technological growth
  C. Basic alternate sources
    1. Solar
      a. Heat
        1. Air
        2. Liquid
      b. Producing electricity
      c. Transmission
      d. Storage
      e. Possible applications
    2. Water
      a. Rivers
      b. Tidal
        1. Storage
        2. Wave action
      c. Possible applications
    3. Wind
      a. Principles
      b. Conventional
        1. Mechanical work

c. High efficiency
1. Manufacture of electricity
d. Possible applications

4. Geo-Thermal
a. Principle of operation
b. Uses
1. Heat
2. To drive turbines
c. Natural locations
d. Transmission
e. Possible applications

5. Methanol
a. Principle of operation
b. Past importance
c. Method of manufacture

6. Hydrogen
a. Principle of operation
b. Method of manufacture
c. Safety hazzard
d. Possible applications

7. Coal liquidification and gasification
a. Review of current coal usage
b. Method of manufacture
c. Ecological concerns
d. Possible applications

8. Oil shale
a. Principle of operation
b. Method of manufacture
c. Natural locations
d. Ecological concerns
e. Possible applications

9. Breeder reactors
a. Review of current nuclear fuels
b. Principle of operation
c. Safety hazzard
d. Ecological concerns
e. Possible applications

VI. Energy Conservation
A. Methods of conservation
1. Around the home
2. Transportation
3. Industrial
B. Designing for energy conservation
1. Houses
2. Automobiles

VII. Occupations involved with or related to alternate energy sources
A. Automobile design engineer
B. Chemist
C. Insulation installer

Alternate Energy Sources

D. Solar heater manufacturer
E. Mine worker
F. Wind generator installer
G. Heater/Air conditioning repairman

BEHAVIORAL OBJECTIVES - ALTERNATE ENERGY SOURCES

A student enrolled in alternate energy sources shall be able to:

1. Establish the relationship of man's dependence on nature for its sources of power.

2. Understand the current and future energy needs for better management and conservation.

3. Identify and discuss possible alternate energy sources, and some of their advantages and disadvantages.

4. Demonstrate safe practices and procedures when working in the shop.

5. Develop an appreciation of quality materials and good workmanship involved in the selection of energy consuming devices.

6. Become aware of occupational opportunities in energy conservation, and possibilities for further experience and education.

SELECTED TEXTBOOKS FOR ALTERNATE ENERGY SOURCES

Anderson, Bruce. The Solar Home Book. Harrisville, New Hampshire: Cheshire Books, 1976.

Calvin, Spies, Konzo, and Thomas. 350 Ways to Save Energy (and money) In Your Home and Car. New York, New York: Crown Publishers, Inc., No date given.

Hoke, John. Solar Energy. New York, New York: Frankline Watts, Inc., 1977.

Meyers, Leo A. Nuclear Power in Industry. Chicago, Illinois: American Technical Society, 1974.

Watson, Donald. Designing and Building a Solar House. Charlotte, Vermont: Garden Way Publishing, 1977.

* See also current issues of Popular Mechanics and/or Popular Science for up-to-date inventions and projects.

METHODS OF INSTRUCTION

Power technology is one of the areas in education, which allows the instructor to use a variety of methods for materials presentation. These varying methods allow the instructor to experiment and improvise. By matching the material content to the teaching technique, maximum student comprehension can be realized.

Some suggested methods of instruction are as follows.

1. Lecture - Usually a formal type of presentation whereby new material is orally given to the student. There is very little, if any, interaction between the students and the lecturer.

2. Lecture demonstration - Often times utilized in laboratory type classes, this method finds the instructor orally presenting new material, and then reinforcing it through the demonstration on a model of, or an actual piece of, equipment.

4. Class discussion - In this method the students are encouraged to question and discuss with the instructor and fellow classmates, any material (or related material) from previous lectures. This method hopefully realizes many of the students' needs, since the questions and responses are often generated by the students themselves.

4. Lab experiences - Hands on activities provide a very meaningful learning experience for many students. Often associated with "shop" courses, activities and projects usually have high student appeal.

5. Related information - This category provides supplementary materials, that may include any or all of the following methods:

a. Assignment sheets
b. Information sheets
c. Text assignments
d. Bulletin boards
e. Audio-visual presentations
f. Field trips
g. Guest speakers

CLASS SIZE

In the power technology curriculum, as with any industrial arts course, a contributing factor of success is the teacher's ability to have a course of instruction that not only offers practical academics, but also provides the students with "hands on" laboratory experiences.

Because of this "hands on" teaching method, the size of the class becomes a critical factor. For reasons of safety, utilization of specialized tools and equipment, and satisfactory teacher supervision, it is imperative that a relatively low student to teacher ratio be maintained. For the courses outlined in this curriculum guide, it is suggested that approximately twenty individual work stations can accommodate between sixteen and twenty-four students comfortably. Fewer students than this can sometimes become "suffocated" by too much supervision, while groups larger than twenty-four usually encounter difficulty in efficient use of tools and equipment. Instructors may also find it more difficult to offer assistance at times when it would be most helpful.

Unfortunately class size is too often dictated by such things as student demand and funding available, but the figure of sixteen to twenty-four students per class is felt to be accurate here.

EVALUATION OF TEACHERS AND STUDENTS

It is not the intent of this curriculum guide to design and write examinations for use in the classroom. Examination content will vary with instructor, teaching methods employed, and individual board of education requirements. It is important to provide evaluation methods that are well suited for use in an industrial arts setting.

The evaluation methods suggested take the form of both traditional teacher-student methods, and non-traditional student-teacher methods. In the first method of teacher-student evaluation, the instructor's evaluation responsibility can be broken into the following three areas: technical knowledge, manipulative skills, and observable judgments. Technical knowledge can be checked through written examinations, oral and written reports, group projects, and individual student instructional abilities. Manipulative skills can be evaluated through performance on competency tests, efficiency and accuracy of completed work, and the care and use of tools and equipment. The final portion of teacher-student evaluation is made through the instructor's observations. Here student attitude, appearance, cooperation, respect for property, respect for authority, and problem solving abilities are noted.

From these three broad categories, a fair grading system can usually be derived that is acceptable to the instructor, the students, and the administration.

Equally important is the evaluation of the instructor, as the teacher of the course, by the student. Oftentimes overlooked by many, student-teacher evaluation provides a method of constructive criticism for increasing teaching effectiveness. Suggested instructor responsibilities that could be measured by a student-teacher evaluation are: course format, technical and related content, guidance, shop management, equipment operation, and shop security. It must be emphasized that student-teacher evaluations should be used solely by the instructor for self-improvement, and not as a gauge of teacher popularity for other reasons.

By integrating both teacher-student and student-teacher evaluative techniques into the industrial arts program, an efficient system of checks and balances can evolve, encouraging the maximum effectiveness in industrial arts instruction.

CONCLUSION

It is evident that power technology taught in industrial arts should be included as a part of general education.

It is the author's feeling that the industrial arts curriculum in a modern American school should include the following seven courses: 1) Exploratory power technology, 2) Electricity, 3) Electronics, 4) Small gas engines, 5) Automotive repairs, 6) Transportation, and 7) Alternate energy sources.

Furthermore, by varying the methods of instruction, regulating class size, and providing a means for both student and instructor evaluation, the entire industrial arts program will be improved. The addition of power technology will increase the effectiveness of the industrial arts program in preparing today's students to become more efficient producers and consumers in a world where technology is unceasingly expanding.

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Books

Fundamentals of Service Engines. Moline, Illinois: Deere and Company, 1977.

A Guide for Equipping Industrial Arts Facilities. Washington, D. C.: American Industrial Arts Association, 1971.

Guidelines for Planning Industrial Education Facilities and Equipment. Madison, Wisconsin: Wisconsin Department of Public Instruction, 1968.

Industrial Arts Curriculum Guide for Transportation. Louisiana: Louisiana State Department of Education, 1974.

Industrial Arts for Iowa Schools. Iowa: State of Iowa, Department of Public Instruction, 1969.

Industrial Arts Power Mechanics. Sacremento, California: California State Department of Education, 1970.

Industrial Education Curriculum Guide. Hawaii: Office of Instructional Services, Department of Education, 1973.

Oliver, Albert. Curriculum Improvement. New York, New York: Harper and Row, 1977.

Penderer, N. C. and Wilber, G. O. Industrial Arts in General Education. New York, New York: Intext Educational Publishers, 1973.

U. S. Department of Health, Education, and Welfare. Planning and Designing Functional Facilities for Industrial Arts Education. Washington, D. C.: U. S. Government Printing Office, 1968.

Microform Reproductions

Electricity Electronics for Intermediate and Junior High Schools. Brooklyn, New York: New York City Board of Education, N. Y. Bureau of Curriculum Development. Eric Document Reproduction, ED 091 554, 1971.

Henderson, W. Charles and Others. General Mechanical Trades: A Curriculum Guide. Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, Eric Document Reproductions, ED 114 595, 1973.

Microfiche Collection of Clearinghouse Documents Reported in Abstracts of Instructional Materials in Vocational and Technical Education (AIM), Volume 5, Number 1. Columbus, Ohio: Ohio State University, Center for Vocational and Technical Education, Eric Document Reproductions, ED 059 407, 1972.

Microfiche Collection of Clearinghouse Documents Reported in Abstracts of Instructional Materials in Vocational and Technical Education, (AIM), Volume 5, Number 2. Columbus, Ohio: Ohio State University, Center for Vocational and Technical Education, Eric Document Reproductions, ED 062 563, 1972.

Microfiche Set of Documents Announced in Abstracts of Instructional and Research Materials in Vocational and Technical Education (AIM-ARM), Volume 7, Number 1. Columbus, Ohio: Ohio State University, Center for Vocational and Technical Education, Eric Document Reproductions, ED 094 269, 1974.

Microfiche Set of Documents Announced in Abstracts of Instructional and Research Materials in Vocational and Technical Education. Columbus, Ohio: Ohio State University, Center for Vocational and Technical Education, Eric Document Reproductions, ED 094 271, 1974.

O'Brien, Ralph D. Orientation: Automotive Mechanics Instructional Program, Block I. Lexington, Kentucky: Kentucky University, Vocational Education Curriculum Development Center, Eric Document Reproductions, ED 198 401, 1973.

Parson, William E. Develop a Prevocational Program for Freshman Students in a Comprehensive Area Vocational School. Indiana: Hammond School City, Eric Document Reproductions, ED 112 216, March 1975.

Power and Energy: Industrial Arts Curriculum Guide, Grades 9-12. Banton Rouge, Louisiana: Louisiana State Department of Education, Eric Document Reproductions, ED 120 543, 1974.

Program of Studies: Industrial Arts: Grades 7-12. Virginia: Fairfax County School, Eric Document Reproductions, ED 109 504, September 1974.

Skuse, Harland G. Basic Electricity: Theory and Practice. New Jersey: State of New Jersey, Department of Education, Division of Vocational Education, Eric Document Reproductions, ED 051 118, 1964.

A Suggested Planned Course in Industrial Arts, Grades 7 and 8. Harrisburg, Pennsylvania: Pennsylvania State Department of Education, Harrisburg Bureau of Curriculum Services, Eric Document Reproductions, ED 105 141, 1973.